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SCUTCHING MACHINE for fiber flax

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Circular No. 975

UNITED STATES DEPARTMENT OF AGRICULTURE

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The project reported here was carried out cooperatively by the Agricultural Engineering Research Branch, Agricultural Research Service, United States Department of Agriculture, and the Oregon Agricultural Experiment Station.

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SCUTCHING MACHINE for Fiber Flax

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INTRODUCTION

Studies of the processing of flax have been under way since 1938 in the Willamette Valley of Oregon, the one area in the United States that now produces this crop commercially. Department of Agriculture engineers at the Oregon Agricultural Experiment Station, Corvallis, Oreg., have worked to develop methods and equipment for processing flax that will preserve the inherent quality of the flax fiber and reduce costs. This research has led to development of several new or improved machines and methods for harvesting, deseeding, retting, scutching, and handling the crop.[1] This circular discusses the improved features of the scutcher newly developed at Corvallis, against a background of the development of flax scutching from its beginning.

The manufacture of linen from flax is undoubtedly one of the oldest industries known to man; history tells us that flax has been used for more than 15,000 years. Spinning linen thread and weaving it into fabric were important activities at the dawn of civilization among many peoples of the world.[2]

Flax was one of the first crops planted by the settlers of Jamestown and by the Pilgrims at Plymouth. Many of the women in the early colonies were skilled in spinning and weaving linen and wool fibers. The fabrics used by the settlers were homemade until introduction of the cotton gin (invented in 1793). Use of this machine, the spinning jenny (invented somewhat earlier), and the power loom soon converted cotton from a little known, expensive fabric to a cheap and abundant fabric. By 1830 machine-made cotton fabric had largely replaced linen for domestic use in the United States. However, a small fiber flax industry has existed in this country throughout the years.[3]

[1] Hurst, W. M., Nelson, E. G., Harmond, J. E., and others. THE FIBER FLAX INDUSTRY IN OREGON. Oreg. Agr. Expt. Sta., Sta. Bul. 531, 20 pp., illus. 1953.

[2] Leggett, W. F. THE STORY OF LINEN. 103 pp. Brooklyn, N. Y. 1945.

[3] Robinson, B. B. FLAX-FIBER PRODUCTION. U. S. Dept. Agr. Farmers' Bul. 1728, rev., 28 pp., illus. 1940.

The cultivated flax (*Linum usitatissimum*—the specific name means "most used") is a member of the Linaceae family. Varieties of this species that grow tall and bear seed at the top of a single stem have been developed primarily for fiber and are called fiber flax; others that tend to branch at the base and form several stems, each producing seed, have been developed for seed production and are called seed flax. Fiber flax varieties are bred to form a tall, single-stem plant that normally grows to a greater height than seed flax. Its stem has a woody core, around the core a layer of fibers running from the ground to the tip of the plant, and around this a thin layer of parenchyma (nonfiber) cells. The fibers are cemented to the other parts of the stem by pectins. Seeds are formed in small round pods supported by lateral branches near the tip of the stem.

Processing steps required to extract flax fiber and prepare it for spinning include pulling (harvesting), deseeding (separating the seed pods and seed from the flax stem), retting (rotting to dissolve some of the pectin and thus loosen the fibers), drying (removing the retting water), scutching (separating flax fibers from the core and bark), and hackling (combing). The two chief straw treatments in the scutching operation are the breaking and crushing of the stalk core and the beating and scraping of the fiber to remove the broken core and surface pectin.

From its beginning to the first years of the 20th century, flax scutching was chiefly a hand operation. In the past 50 years, however, development of scutching machinery has changed it to a continuous operation in which a layer of retted flax straw is fed into one end of a machine and a layer of line fiber (long, unbroken strands) is discharged from the other end. The tow (short, tangled fiber) and the woody core, separated from the line fiber in the scutching operation, are removed by mechanical means from the lower part of the scutcher.

The principal steps in flax scutching are discussed here in their actual order.

BREAKING AND CRUSHING

No doubt the original method of breaking the woody core of flax was bending and crushing the stems with the fingers. The next, probably, was laying the flax straw on the ground and flailing it with a tree limb. Another method was beating the flax with a wooden mallet.

A primitive mechanical method of crushing flax straw consisted in spreading the straw radially in a circle on the ground and rolling over it a large stone, attached to a pole of which one end pivoted in the center of the circle as the other end was drawn by a beast of burden.[4]

The American colonists, to crush retted flax straw, used a hand breaker (fig. 1) made by joining heavy wooden slats edgewise in a holding frame. Alternate slats were hinged at one end on a through shaft and would rise and lower at the other end. The other slats, joined to the frame at both ends, remained stationary. Straw was placed on the stationary slats when

[4] PRINGLE, A. V. THEORY AND PRACTICE OF FLAX SPINNING. Part II, mechanics of flax spinning. Belfast. 1951.

FIGURE 1.—Early American flax straw breaker.

the movable slats were in the "up" position. Then the frame was repeatedly closed on the straw, to press it down between the slats and break it.

A mechanical breaker patterned after the hand breaker and called the chopper was used commercially for some years. It had a set of stationary iron bars and, above them, a series of movable shoes spaced so that they could be passed between the stationary bars. A series of cams, turning at a rate of about 250 r. p. m., moved the shoes up and down in a chopping motion. The flax straw, mechanically moved between the stationary bars and the movable shoes, was thoroughly broken by the chopping action.

Mechanizing continued through the use of a single pair of smooth pressure-loaded rollers and then many pairs of such rollers. Finally multiple pairs of spring-loaded fluted rollers were substituted. These constitute a part of the present-day commercial scutching machine (fig. 2). Many variations of roller location, size, and speed have been tested, also many variations in number and size of teeth. In the present machines all the rollers are the same size and rotate at the same speed, and the top roller is spring loaded to compensate for variation in depth of the straw layer. In different makes of scutcher the number of roller pairs ranges from 5 to 7. The rollers are about 5½ inches in diameter, and each has 18 teeth. The teeth on vertically paired rollers mesh loosely. A cutaway section at the center of each roller accommodates a gripping and conveying device. This device pulls the straw through the breaker in the form of a V. As the straw passes between the sets of fluted rollers, this type of machine does a fair job of breaking the woody core in the ends. However, the core remains unbroken in a 3- to 8-inch midsection of the straw, because this section travels through the cutaway sections of the breaker rollers. A more severe beating and scraping action is required to clean this part of the straw. Such treatment reduces the line fiber yield and increases the percentage of the cheaper tow fiber.

The breaker recently developed by research engineers in the project carried on by the Department of Agriculture and the Oregon Agricultural Experiment Station is a revolutionary departure from any of its predecessors. It has four parallel, equally spaced fluted rollers connected by a train of planetary gears (fig. 3). The gears revolve the rollers so that the teeth mesh with, but do not touch, 17 stationary bars, or concave teeth, 4 feet long, that are equally spaced around approximately one-fourth

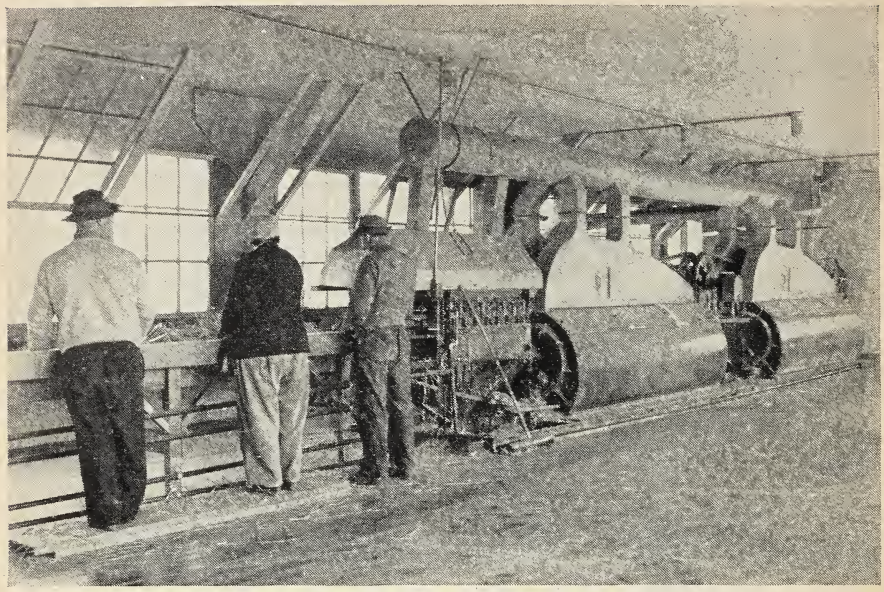

FIGURE 2.—Present-day commercial scutcher, comprising feed table, straw breaker, and turbines.

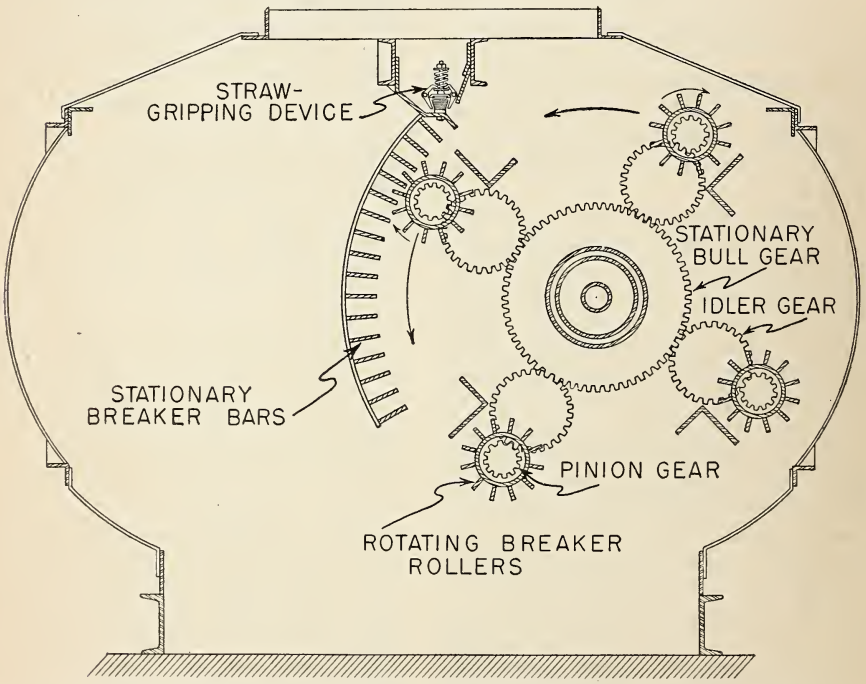

FIGURE 3.—Section through the newly developed flax-scutcher straw breaker showing rollers, stationary bars, and straw-gripping device.

of the circumference of a 25-inch circle. The first bar on the concave is tapered so that its depth of mesh with the revolving breaker roll gradually increases from zero at one end to the full depth of the bar at the other end of the 4-foot breaking section.

As the straw, held at one end by the gripping device, is conveyed through the breaker, the meshing of the flutes with the breaker bars causes it to be "crimped" to a depth of about 1½ inches, whereas in the present commercial breakers the depth of crimping is only ½ or ¾ inch. Moreover, the taper of the bars on the rotor causes the straw to be broken at different places each time it comes into contact with them.

Two breaking units of this kind are integrated into the improved scutching machine; one is located in each of two turbines (figs. 4, 5).

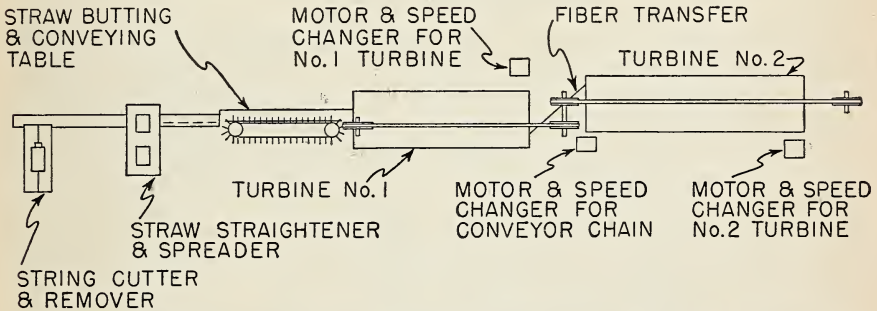
STRAW BUTTING & CONVEYING TABLE
MOTOR & SPEED CHANGER FOR No.1 TURBINE
FIBER TRANSFER
TURBINE No.2
TURBINE No.1
MOTOR & SPEED CHANGER FOR CONVEYOR CHAIN
MOTOR & SPEED CHANGER FOR No.2 TURBINE
STRAW STRAIGHTENER & SPREADER
STRING CUTTER & REMOVER

FIGURE 4.—Equipment arrangement for newly developed scutcher and its auxiliaries.

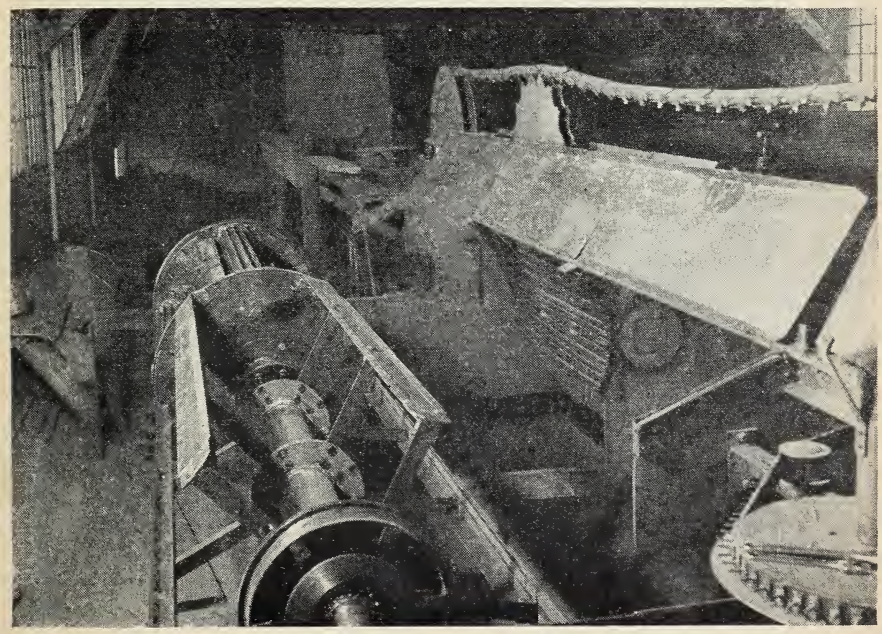

FIGURE 5.—Newly developed flax scutcher with breaker and beater section removed from one turbine.

When the straw has been conveyed by a gripping chain through one turbine, it is transferred to a second gripping chain, which conveys it through the second turbine.

Shives (fragments of broken core) fall through from between the stationary bars into a suction-fan manifold located beneath the scutcher turbine.

The two chief advantages of this breaker are: (1) The fact that the flutes and bars mesh without touching, with the result that they break the core but do not bruise the fiber; and (2) the fact that the straw is broken throughout its length and is broken doubly for a distance of 2 or 3 inches, whereas scutcher breakers of the kind now in general use leave from 3 to 8 inches of the straw unbroken.

BEATING AND SCRAPING

An old method of beating and scraping flax was to drape the broken straw over a support and repeatedly strike it slanting blows with the edge of a wooden paddle until the shives had been removed.

The hand paddle was expanded into the power-driven Flemish mill, which consists of a series of hardwood paddles, called handles, and a frame and hub to which the paddles are bolted so that they will rotate near a stationary member called the stock (fig. 6). The broken straw is held over the stock while the rotating paddles flail out the shives and polish the fiber. The Flemish mill was for many years the principal machine used in scutching and dressing flax, and it is still commonly used in some parts of the world. Several such mills are still being used in the United States, but only for cleaning and finishing rejected turbine-scutched line fiber. The most commonly used types of Flemish mill are the Belgian wheel and the Irish wheel. The Belgian unit usually has 12 to 17 highly polished mahogany handles mounted in a fabricated wrought-iron frame, constituting a 6-foot-diameter wheel. The Belgian mills are driven at about 150 r. p. m., striking approximately 1,800 blows a minute and having a tip velocity of about 2,700 f. p. m. The Irish wheel resembles the Belgian unit in design but is much heavier and more rugged. It consists of a frame, drive, stock, and 5 or 6 hardwood handles bolted to a cast-iron hub. The Irish wheel has virtually the same diameter as the Belgian, but it is operated at a higher speed; in some installations its peripheral speed approaches 6,000 f. p. m.

Many other devices for beating and scraping flax straw have been designed, involving several different principles. They range from the counterbalanced monoblade to the extralong, multispeed, 4-drum machine having hardwood fiber polishers added to the blades on the second and fourth turbines. Turbine scutchers now used in the United States are of the twin-beater type and are similar in operation. As the straw leaves the first turbine, the cleaned end is picked up by a transfer belt and fed into the gripping and conveying device of the second turbine, which holds it while the other part of the straw is cleaned. The scutched fiber is then released on the takeoff bar at the rear of the machine. In comparison with the scutching wheel the turbine scutcher facilitates straight-line operation, cleans the fiber much more rapidly, and greatly increases production per man-hour. The chief differences in beating and scraping equipment between turbine scutch-

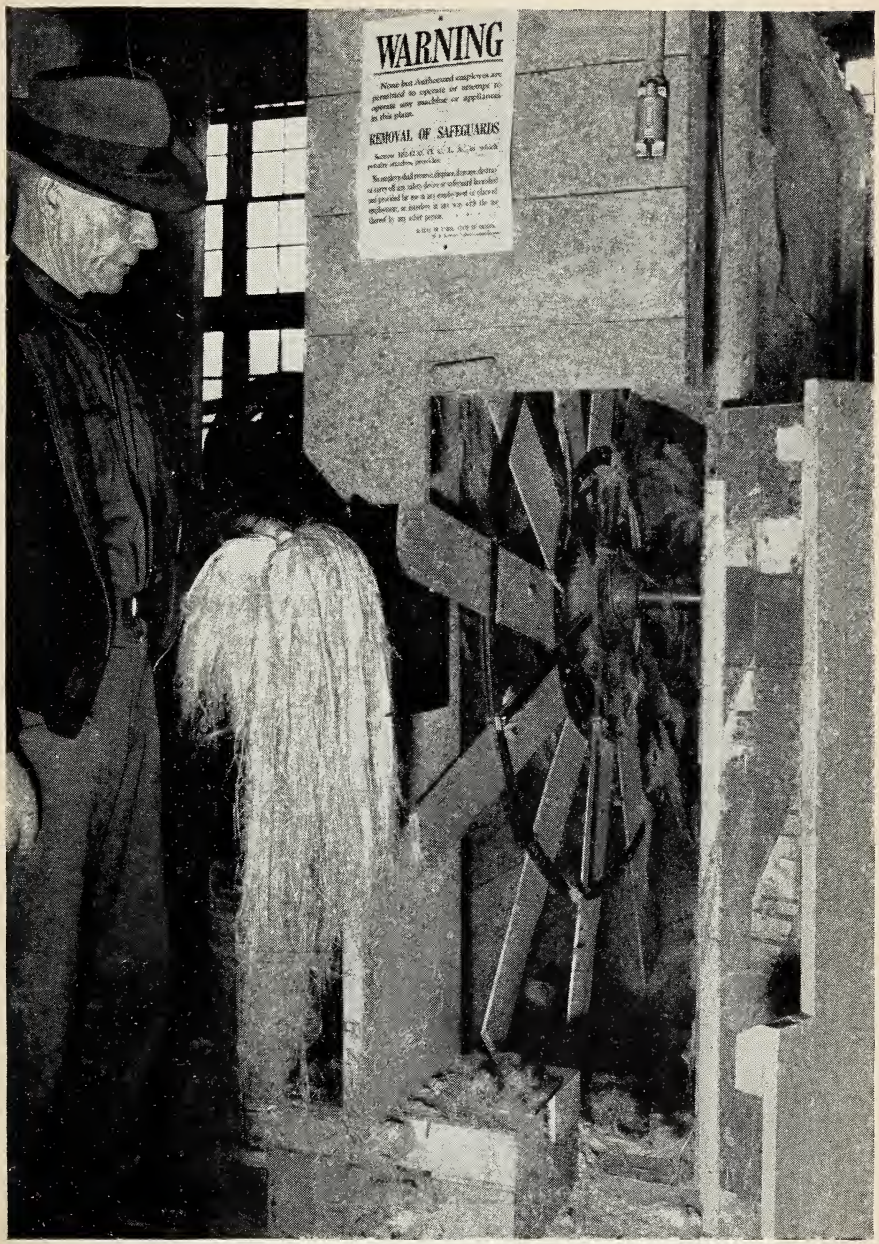

FIGURE 6.—Flemish mill in use in an Oregon flax-processing plant.

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ers discussed here are differences in number of blades and in blade design.

Number of Blades

Turbine scutching machines now used in the United States have from 3 to 6 blades to a beater (figs. 7–9). Considerable research was conducted by engineers of the cooperative project on blade number and design and on additions such as combs and wooden polishers. It was found that on well-retted flax straw, with the machines properly adjusted, 3-, 4-, 5-, and 6-blade beaters all processed the fiber satisfactorily. On under-retted straw the 3- and 4-blade machines, irrespective of increased speed and of blade design, would not clean the fiber but would chop off its ends, and the 6-blade machine proved the most effective. On weak or over-retted straw the 3-blade machine gave the best results and the 6-blade machine proved to be severe. The minimum angle the fiber makes around the scutcher blades in the 4-blade beater is about 107° and occurs 4½ inches away from the gripping device (fig. 10). In the 6-blade beater the minimum angle is about 78° and occurs only 2 inches from the gripping device. The consequent severe action frequently causes weak fiber to fail at this point. For the average run of flax the 6-blade machine was too severe, reducing a high percentage of the line fiber to tow, and the 4-blade machine was not severe enough. The 5-blade beaters, having a minimum fiber-contact angle of about 90° occurring approximately 4 inches from the gripper, exhibit a uniform scutching action.

On the basis of the research findings, twin 5-blade beaters were used in the turbines of the experimental scutcher.

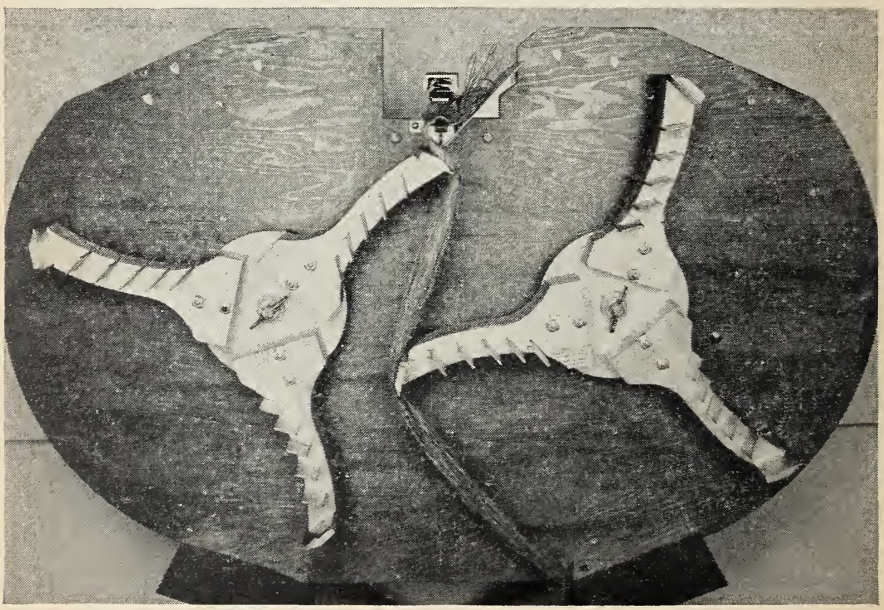

FIGURE 7.—Model of cross section through the turbine of a 3-blade commercial scutcher showing gripping device, scutching blades, and angle of contact with the fiber.

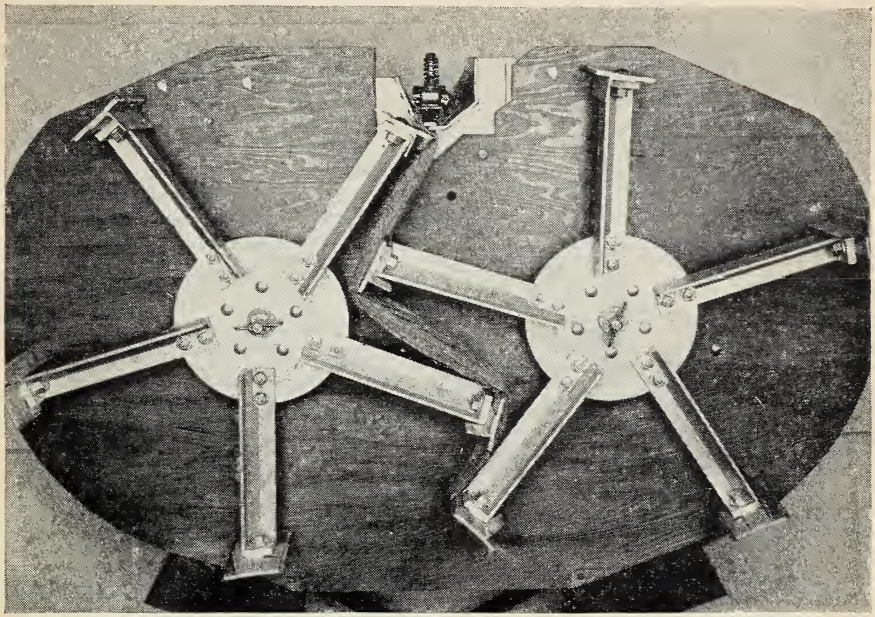

FIGURE 8.—Model of cross section through the turbine of the newly developed 5-blade scutcher, showing gripping device, scutching blades, and angle of contact with the fiber.

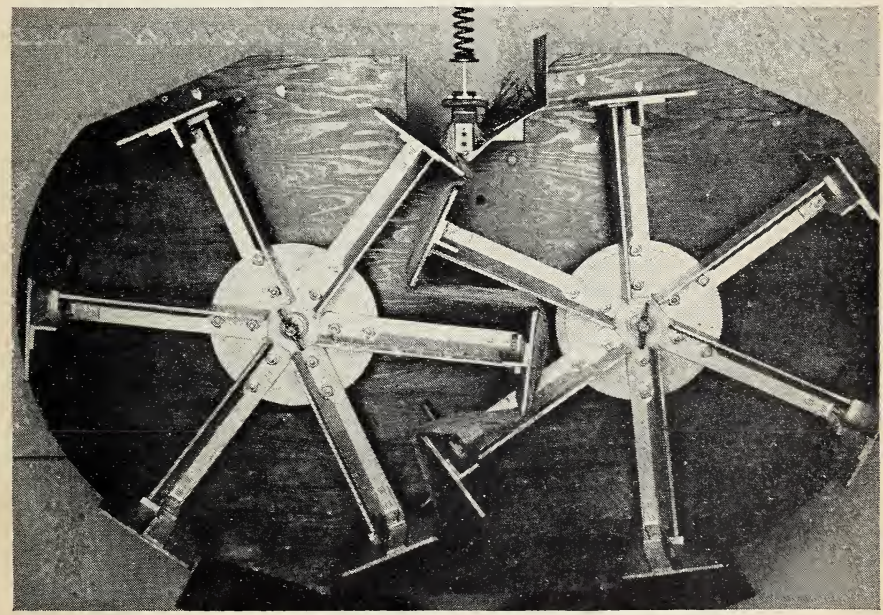

FIGURE 9.—Model of cross section through the turbine of a 6-blade commercial scutcher, showing gripping device, scutching blades, and angle of contact with the fiber.

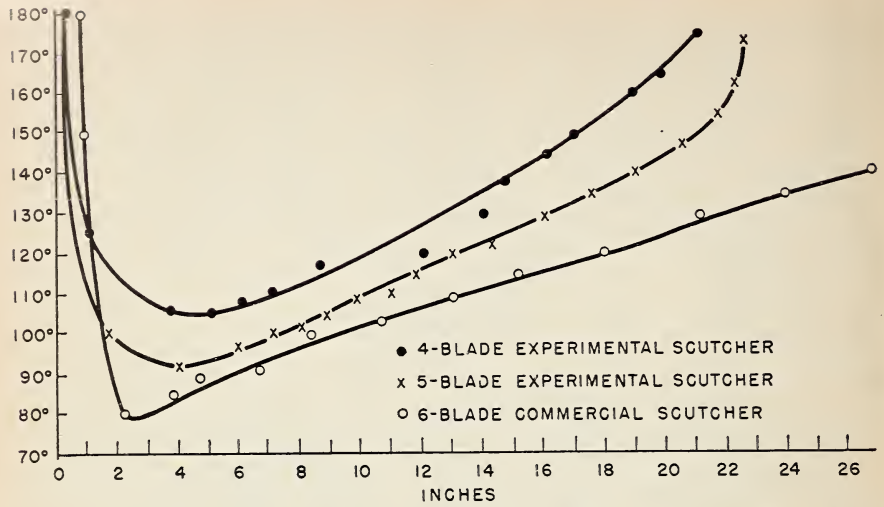

FIGURE 10.—Angle of contact of flax fiber with scutcher blade during processing, by distance from gripping device to blade.

Blade Design

Many types of fiber-contact blades were tested, including angle irons, channel irons, flat plates with sharpened edge, and flat plates with hardened steel strips on the top of the leading edge and the bottom of the trailing edge. Additional bars were tested on the beater arms but were soon abandoned because they seemed to reduce the cleaning action instead of increasing it. Hardened surfaces are necessary, for the straw and fiber are very abrasive and soon cut grooves in the surface of mild steel. As a result of the tests the blades on the new scutcher are of the flat type with 1-inch by $\frac{1}{16}$-inch spring-steel straps riveted to the leading and trailing edges.

A series of combs was tested on the beater blades and was found to improve the cleaning action and dress of the fiber without sacrifice of line fiber yield. Addition of combs made it possible to operate at a 10- to 15-percent lower speed and still clean the fiber satisfactorily. Any increase in power requirements caused by adding the combs was offset by this reduction in speed of operation of the beaters. The combed fiber had the appearance and feel of machine-hackled fiber. However, it was found to be much harder to control on the scutcher takeoff, and when handled it tangled far worse than fiber scutched without combs. On the basis of these findings all but a few coarse pins of the combs were removed and were replaced with a half-round hardwood polishing bar. From the middle of the blade to the discharge end, a series of 12 pins $\frac{3}{16}$ inch in diameter, spaced on $\frac{5}{16}$-inch centers, and a $1\frac{1}{4}$-inch half-round maple polishing bar were placed so that the fiber was combed and polished as it left each turbine section.

GRIPPING DEVICE

Tests of different devices for gripping the flax straw and conveying it through the scutching machine have led to acceptance of these

three types, all of which are now in use in this country: (1) The alligator spring-clip belt, (2) the male and female rubber belt, and (3) the mechanical link and V-belt.

The alligator spring-clip belt (fig. 11) is identical in size and action in the two scutching sections except that in the first section it is several feet longer; the extra length is to accommodate the breaker shown in figure 2. The gripping device consists of a lower belt 1⅛ inches wide and ½ inch thick, a stripper belt 1⅛ inches wide and 3/16 inch thick, and a 2-ply canvas upper belt 3/16 inch wide with a series of spring-steel clips riveted to it so that the clips dovetail into each other and fit firmly over the lower belts. The straw and fiber are gripped between the lower and stripper belts. A spring-loaded pressure rail that rides on the upper belt and forces the spring clips over the straw and lower belts and against a lower slide rail increases the gripping force. The stripper belt is slightly longer than the conveyor and extends beyond it at the discharge end of the machine, clearing the straw and fiber from the spring clips. This type of belt performs very well if kept in proper adjustment, but it is difficult to keep the spring clips adjusted. Uneven feeding of straw into the machine causes the clips to break or to become strained and lose their gripping force. When a nonuniform layer of straw enters the chain the heavy part raises the spring-loaded slide rail, and this reduces the holding pressure on thin parts and permits some loss of straw from the gripping belt. This is especially noticeable at the entrance of the second turbine.

The male and female rubber belt (fig. 11) consists of heavy U-shaped sections, the female section on top. These grip in the same manner as the clip belt, with the difference that the resilience of the rubber, instead of the spring in the steel clip, furnishes the side grip. The spring-loaded rigid upper bar

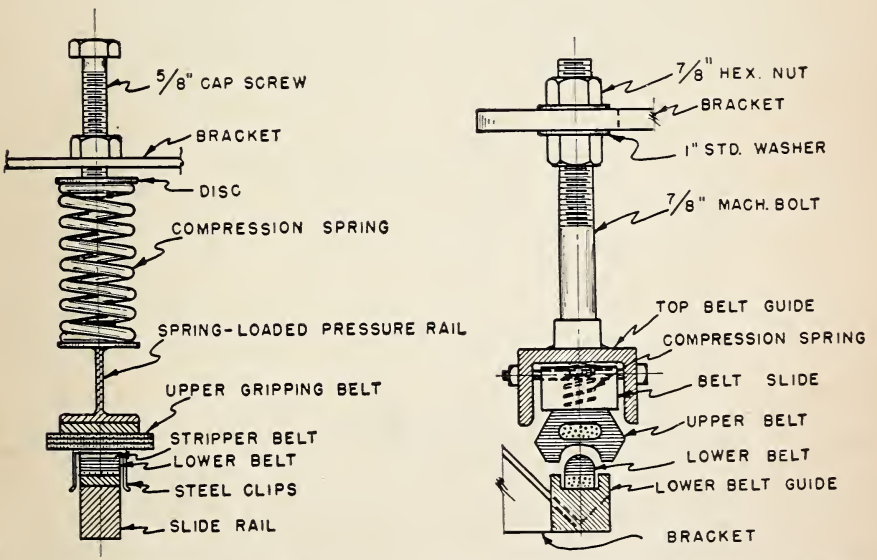

FIGURE 11.—Cross-section diagrams of commercial scutcher gripping devices: Alligator spring-clip belt (left); male and female rubber belt (right).

is replaced with a spring-loaded thin metal strip that flexes somewhat as the thickness of the straw layer varies. This device operates with less mechanical difficulty than the clip belt, but it does not have sufficient grip to prevent straw and fiber from being pulled from the conveyor during the scutching operation.

The gripping device used in the experimental scutcher is the mechanical link and V-belt (fig. 12). This device is a rugged one. It grips the straw and fiber so firmly that they will break before they will slip from the chain. Each link of the chain grips a 5-inch section of the straw and fiber by means of spring-powered side plates that close and force the straw around a standard D-section transmission V-belt. The chain has a pitch of 5 inches. A coil spring activates a lever arm that pivots over the link pin and applies pressure on the hinged side plates when the chain is traveling in a straight line but relieves the pressure when the chain is traveling around the chain sprockets, allowing the flax to enter and to leave the chain.

A transfer belt between the first and second turbines whose surface speed is the same as that of the conveyor belts, or slightly greater, transfers the fiber from the first to the second gripping device so that the unscutched part of the straw can be cleaned. The fiber scutched in the first turbine is picked up by the transfer belt as it emerges and is gradually guided sideways to a horizontal position in which it is gripped by the second turbine chain. This occurs before the straw is released from the grip of the first turbine chain. Several methods of keeping the uncleaned ends of the fiber abreast of the gripped ends have been used, including air jets, corrugated-edged rubber belts, and pin belts. In this country only the pin-belt principle is being used.

Owing to the unique gripping device on the experimental scutcher, the offset between the two turbines has been reduced from about 7½ inches to about 5 inches. The narrowness of the offset makes it possible to scutch straw so short that in a commercial machine it would become tow.

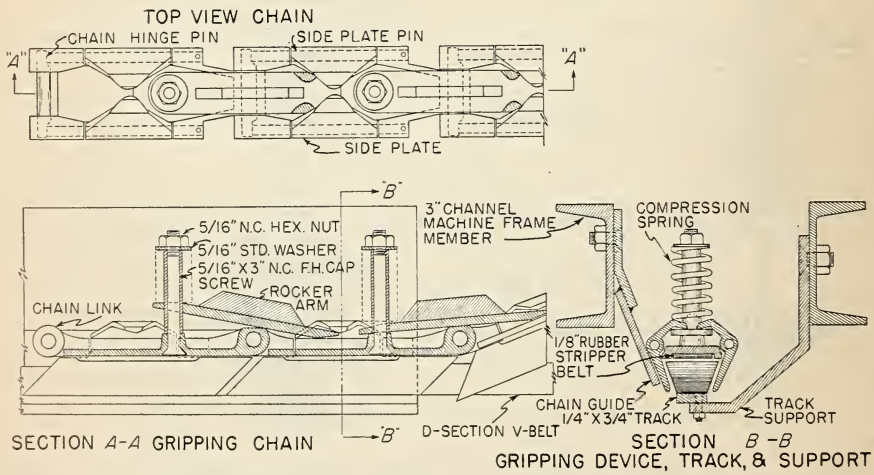

FIGURE 12.—Gripping device of newly developed scutcher: Top, side, and cross-section views.

AUXILIARY EQUIPMENT

In addition to the improvements discussed in the foregoing, the experimental scutcher has new auxiliary equipment (fig. 4) that improves the efficiency of the scutching operation. A string cutter automatically cuts and removes the bundle string. A straw spreader combs the straw, spreads it, and then feeds it into the butter feed table, which butts and conveys it into the first scutching turbine. Also, a downdraft dust-elimination and tow-removal system reduces dust concentration in the working area.

SCUTCHER DRIVES

Drives used for turbine scutchers have ranged from the central power unit that propels various parts through a jackshaft and a series of either flat belts or V-belts and pulleys to individual motors that drive them through a speed changer and V-belts. In any case, from 20 to 25 horsepower is required to drive the scutcher blades, breaker, and gripping and conveying device satisfactorily. The individual drive is desirable in that it gives accurate speed change and each part can be adjusted independently. The new scutcher is propelled by separate electric motors and speed changers (fig. 13). The breakers and beaters are driven by a 7½-horsepower 220-volt, 60-cycle totally enclosed electric motor on each turbine. The breakers are driven from the constant speed shaft of the speed changer at approximately 150 r. p. m., and the beaters from the variable speed shaft at a rate ranging from 100 to 300 r. p. m. The gripping and conveying chain is powered by a 5-horsepower electric motor of the same type and has a speed through the machine ranging from 40 to 160 f. p. m. The first section of the conveying chain is propelled from the center shaft; the second section, from the fiber take-off by means of a roller chain. In both cases the power is applied so that the chain is pulled through the machine.

TESTS IN COMMERCIAL MILL

The new scutcher has been operated in a flax-scutching plant under commercial conditions since 1945 (fig. 14). With a few alterations, the unit has given excellent service while scutching several thousand tons of flax. Its capacity is equal to that of the commercial machines, and it has been judged to prepare the fiber as well as or better than they do. In comparison tests in the plant the new machine has extracted, on an average, 15 to 20 percent more line fiber from equivalent retted straw than the other machines.

Results of a test in which the experimental scutcher was used with and without combs are presented in table 1. The 2.4-percent advantage, on the retted-flax basis, in the line fiber yield obtained by using the experimental scutcher with combs rather than a commercial scutcher represents a gain of about 16.4 percent in line fiber. Results of a test in which bundles of retted flax from five mills were halved and the halves of each were scutched with the experimental and a commercial machine, respectively, are presented in

table 2. In this test, the additional 4-percent yield of fiber obtained with the experimental scutcher from a given quantity of flax represents a gain of about 25 percent in line fiber.

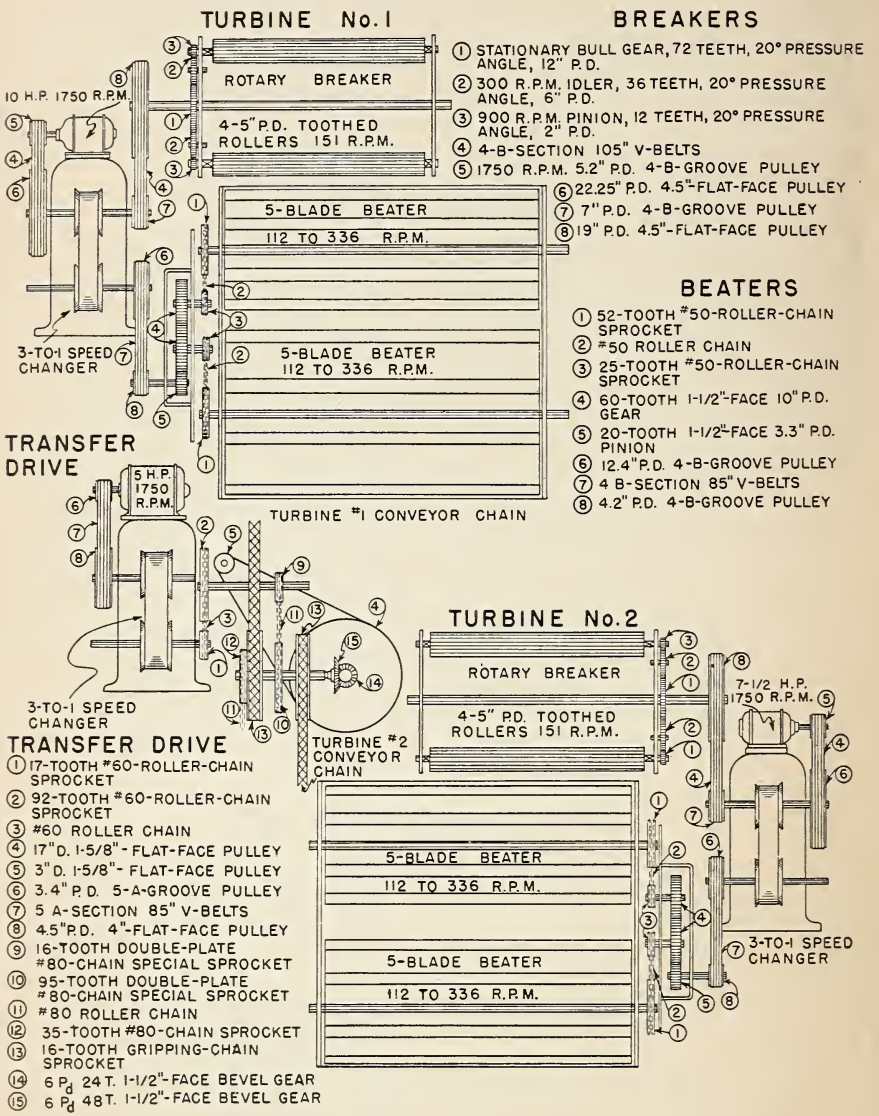
TURBINE No.1
ROTARY BREAKER
4-5" P.D. TOOTHED ROLLERS 151 R.P.M.
10 H.P. 1750 R.P.M.
5-BLADE BEATER
112 TO 336 R.P.M.
3-TO-1 SPEED CHANGER
5-BLADE BEATER
112 TO 336 R.P.M.
TRANSFER DRIVE
5 H.P. 1750 R.P.M.
TURBINE #1 CONVEYOR CHAIN
3-TO-1 SPEED CHANGER
TURBINE #2 CONVEYOR CHAIN
TURBINE No.2
ROTARY BREAKER
4-5" P.D. TOOTHED ROLLERS 151 R.P.M.
7-1/2 H.P. 1750 R.P.M.
5-BLADE BEATER
112 TO 336 R.P.M.
5-BLADE BEATER
112 TO 336 R.P.M.
3-TO-1 SPEED CHANGER
BREAKERS
① STATIONARY BULL GEAR, 72 TEETH, 20° PRESSURE ANGLE, 12" P.D.
② 300 R.P.M. IDLER, 36 TEETH, 20° PRESSURE ANGLE, 6" P.D.
③ 900 R.P.M. PINION, 12 TEETH, 20° PRESSURE ANGLE, 2" P.D.
④ 4-B-SECTION 105" V-BELTS
⑤ 1750 R.P.M. 5.2" P.D. 4-B-GROOVE PULLEY
⑥ 22.25" P.D. 4.5"-FLAT-FACE PULLEY
⑦ 7" P.D. 4-B-GROOVE PULLEY
⑧ 19" P.D. 4.5"-FLAT-FACE PULLEY
BEATERS
① 52-TOOTH #50-ROLLER-CHAIN SPROCKET
② #50 ROLLER CHAIN
③ 25-TOOTH #50-ROLLER-CHAIN SPROCKET
④ 60-TOOTH 1-1/2"-FACE 10" P.D. GEAR
⑤ 20-TOOTH 1-1/2"-FACE 3.3" P.D. PINION
⑥ 12.4" P.D. 4-B-GROOVE PULLEY
⑦ 4 B-SECTION 85" V-BELTS
⑧ 4.2" P.D. 4-B-GROOVE PULLEY
TRANSFER DRIVE
① 17-TOOTH #60-ROLLER-CHAIN SPROCKET
② 92-TOOTH #60-ROLLER-CHAIN SPROCKET
③ #60 ROLLER CHAIN
④ 17" D. 1-5/8" - FLAT-FACE PULLEY
⑤ 3" D. 1-5/8" - FLAT-FACE PULLEY
⑥ 3.4" P.D. 5-A-GROOVE PULLEY
⑦ 5 A-SECTION 85" V-BELTS
⑧ 4.5" P.D. 4" -FLAT-FACE PULLEY
⑨ 16-TOOTH DOUBLE-PLATE #80-CHAIN SPECIAL SPROCKET
⑩ 95-TOOTH DOUBLE-PLATE #80-CHAIN SPECIAL SPROCKET
⑪ #80 ROLLER CHAIN
⑫ 35-TOOTH #80-CHAIN SPROCKET
⑬ 16-TOOTH GRIPPING-CHAIN SPROCKET
⑭ 6 P_d 24 T. 1-1/2"-FACE BEVEL GEAR
⑮ 6 P_d 48 T. 1-1/2"-FACE BEVEL GEAR

FIGURE 13.—Schematic diagram of newly developed scutcher showing drive motors, speed changers, and scutcher parts.

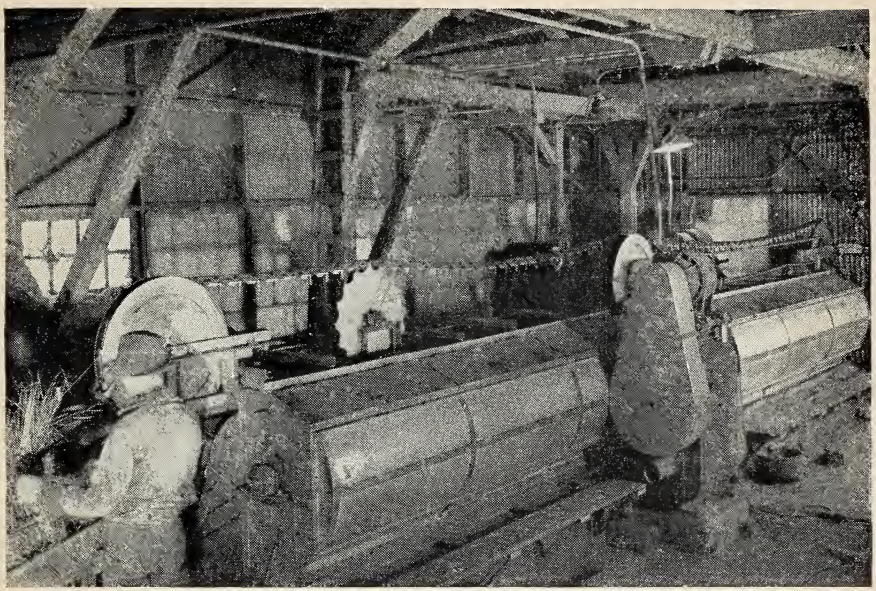

FIGURE 14.—Newly developed scutcher being operated in a commercial flax-processing line.

TABLE 1.—*Results of test of experimental scutcher with and without combs on composite samples of medium-length straw, by cleaning characteristic of straw*

Cleaning characteristic of straw	Line fiber yield of straw in terms of weight of retted flax		
	Commercial scutcher	Experimental scutcher [1]	
		Without combs	With combs
	Percent	*Percent*	*Percent*
Easy	16. 8	18. 7	18. 5
Medium	16. 1	17. 7	19. 5
Hard	10. 9	12. 2	13. 0
Average	14. 6	16. 2	17. 0

[1] Gripping speed, 120 feet per minute; straw feed, 1,500 pounds per hour.

TABLE 2.—*Results of test of experimental scutcher on retted flax from 5 mills, in pounds of fiber and in weight of fiber as a percentage of weight of flax straw* [1]

Mill (No.)	Straw	Line fiber yield			
		Commercial scutcher		Experimental scutcher	
	Pounds	*Pounds*	*Percent*	*Pounds*	*Percent*
1	34. 7	6. 00	17. 3	6. 80	19. 6
2	26. 7	4. 06	15. 2	5. 37	20. 1
3	47. 7	6. 68	14. 0	8. 90	18. 7
4	12. 75	2. 74	21. 5	3. 06	24. 0
5	60. 5	7. 68	12. 7	[2] 10. 95	18. 1
Average			16. 1		20. 1

[1] The test material was bundles selected as representative. Half of each bundle was scutched with the experimental machine and half with a commercial machine.
[2] Scabby—B grade.

CONCLUSION

Basic advantages of the new machine over other scutching machines now used commercially in the United States are a mechanical device for gripping and conveying straw and fiber that reduces the loss of fiber during the turbine beating; a rotary breaker located in the forepart of each of two turbines that thoroughly breaks the straw over its entire length without damaging the fiber; a shorter offset between the two turbines, making possible the scutching of shorter straw; and a downdraft dust-eliminating and tow-removal system that contributes to the health and comfort of the workers and reduces fire hazard.

The new scutcher, used with new auxiliary equipment, improves the scutching operation's efficiency and reduces its labor requirement by at least four men. With the added revenue from line fiber increase and the reduction in labor cost, it is evident that the new equipment would soon pay for itself.

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